REGIONAL DISPARITIES AND EFFECT OF PRIVATE TUITION ON STUDENTS' MATHEMATICS PERFORMANCE: EVIDENCE FROM RURAL WEST BENGAL

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Abstract

Private tutoring has become increasingly prevalent in India due to rising academic competition and concerns regarding learning outcomes within formal schooling. This study examines the effect of private tuition on students' mathematics performance in rural West Bengal, with particular attention to parental education, socioeconomic background, and regional disparities. The study is based on primary cross-sectional survey data collected from 600 students across four districts of West Bengal – Darjeeling, Kaliaganj, Namkhana, and Purba Medinipur, representing diverse geographical and educational contexts. From each district, one administrative block was chosen to capture regional variation in education contexts. Students were administered a standardized mathematics assessment designed based on the National Education Policy (NEP) 2020 learning stage framework. The empirical analysis employs the OLS (Ordinary Least Squares) and AIPW (Augmented Inverse Probability Weighting) estimates that access to private tuition has positively influenced math test scores. The findings indicate that nearly 71% of students receive supplementary private tuition. Female students show slightly higher participation in private tuition, though gender differences remain statistically insignificant. This suggests a gradual reduction in gender disparities in educational support. Parental education appears to have a stronger influence on children's academic achievement than parental income. The interaction effect between parental education and private tuition remains negative, suggesting private tuition provides relatively greater benefits to students from less educated households. District-fixed effects obtained through OLS regression further reveal substantial regional disparities, with students from Namkana, Purba Medinipur, and Kaliaganj achieving significantly higher mathematics scores compared to students from Darjeeling.

Keywords: private tuition, mathematics performance, regional inequality, parental education, Augmented Inverse Probability Weighting, West Bengal

1. Introduction

Education plays a crucial role in shaping students' academic achievement and future opportunities. In recent years, private tuition has become a significant part of the education system in India. Private tuition refers to supplementary teaching received outside regular school hours to improve academic performance. Studies have shown that private tuition has expanded rapidly because many parents believe that regular classroom teaching is insufficient to meet students' academic needs [1]. Students who receive supplementary tutoring may gain better conceptual understanding and enhanced examination performance compared to those relying solely on formal schooling[2].Regional disparities remain a significant challenge in West Bengal, where differences in economic development and infrastructure create unequal access to social and educational opportunities[3]. The present study purposely selected Darjeeling, Kaliaganj, Namkhana, and Purba Medinipur to represent diverse geographical and socioeconomic contexts within the state. Darjeeling is a northern hilly region where difficult terrain and infrastructural constraints may influence educational accessibility. Kaliaganj in Uttar Dinajpur district represents a comparatively lower and socio-economically less developed northern plain region. Namkhana represents the coastal and environmentally vulnerable Sunderban region, where geographical isolation and climatic vulnerability may affect educational opportunities. In contrast, Purba Medinipur represents a comparatively educationally developed southern district with better educational infrastructure and literacy conditions. The selection of these areas enables a comparative understanding of how rural regional diversity shapes educational experiences and participation in private tuition across West Bengal.

Although previous studies have examined the relationship between private tuition and academic achievement in India, limited research has focused on district-level variation in West Bengal, using primary survey data. The study examines the effect of private tuition on students' mathematics test scores using primary data collected from 600 students across four districts of West Bengal: Darjeeling, Namkhana, Purba Medinipur, and Kaliaganj. The research questions in this paper are: Does private supplementary tutoring improve students' academic achievement and learning outcomes? To what extent do parental education, family income, and regional disparities influence students' access to private tutoring? In other words, does the effect of private tutoring on academic performance vary across socioeconomic background and educational contexts? The remaining part of the paper is organised into three sections. Section 2 represents the literature review related to private supplementary tutoring and educational inequality. Section 3 explains the primary data, methodology used for this study, and presents the empirical results and analysis. Section 4 discusses the findings and limitations.

2. LITERATURE REVIEW

Regional disparities in development remain a significant concern in West Bengal. Studies have shown that inter-district inequality has increased over time, with noticeable developmental divergence between the state's northern and southern districts. The unequal distribution of economic growth, industrial development, and service sector expansion has contributed to widening regional imbalances across districts[4].The southern districts show comparatively higher educational development, while the northern and western districts remain educationally backward. Economic backwardness, poverty, weak infrastructure, and socio-cultural barriers were identified as major determinants of educational inequality in the

state [5]. Studies have shown that the north Bengal districts, particularly Darjeeling and other hilly regions, face infrastructure limitations, geographical barriers, and limited educational facilities, which continue to affect educational access in the region [6]. The study highlighted that difficult terrain, inter district disparities, and limited accessibility influences the uneven distribution of educational institutes. Most higher education institutes were concentrated in areas below 1500 meters and along highways, reflecting the impact of physiographic constraints on educational access[7].

Private tuition, often described as "shadow education", has become increasingly common in West Bengal. The weakness of the formal school system, examination pressure, competition for academic success, and parental expectations significantly contribute to the growth of private supplementary tutoring in the state. Private tuition operates alongside formal schooling and becomes deeply embedded with educational culture in West Bengal [8].Another study of Ireland found that private tuition did not significantly improve academic achievement after controlling for socio-economic and attitudinal differences among students [9]. In South Asia, countries like India, Bangladesh, Nepal, Pakistan, and Sri Lanka, where parents increasingly depend on supplementary tutoring because they perceive private education as providing higher-quality learning opportunities and a competitive advantage for their children [10]. In West Bengal, private tuition has become an important part of the informal education market, and it creates educational inequality because economically stronger families are more able to access additional support. The involvement of school teachers in private tuition weakens the formal schooling system[11].

The household income, urban residence, parental education, private school enrolment, and school fees positively influenced private tuition expenditure, while a larger household size has a negative effect, and also, wealthier households spend more on private tuition, indicating[12].A study shows that parents have a positive attitude towards private tuition at the senior secondary level and parents with higher educational and socio-economic backgrounds had a more positive attitude towards private tuition, as they considered it an important supplementary support for improving student academic achievement[13].

Parental education is considered an important factor influencing students' participation in private tuition or shadow education. Parents with higher educational attainment are generally more conscious of academic achievement and competitive examinations, which motivates them to arrange additional academic support for their children through private tutoring[2].Educated parents are also more capable of monitoring their children's learning and understanding the benefit of supplementary education, thereby increasing the demand for private tuition [14].In the Indian context private tuition has become highly prevalent among students due to increasing academic competition, and educated parents are more likely to support coaching classes and subject-specific tuition to enhance their children's educational outcomes [15].Studies conducted in rural India further reveal that private tuition creates educational inequalities because economically disadvantaged rural families are often unable to afford additional coaching support. Students receiving private tuition tend to show better academic engagement and examination preparedness compared to those relying on regular school [16].

This paper aims to address the existing gaps in the literature on private supplementary tutoring and educational inequality in rural West Bengal. The main objective of the study is to examine the effect of private tuition on student academic performance and to analyse how socio-economic regional factors influence access to supplementary tutoring.The study focuses on four rural regions of West Bengal – Darjeeling, Kaliaganj, Namkhana, and Purba Medinipur to capture disparities in education. Further, the study was divided into two class

groups based on the National Education Policy (NEP) framework, classes III to V and classes VI to VII, to check which group is more influenced by private tutoring. The study also investigates whether parental education affects students' participation in private tuition and academic outcomes. Try to understand the regional gap in access to private tuition, ranging from the comparatively low participation observed in Darjeeling to higher participation in Purba Medinipur, Namkhana, andKaliaganj.

3. DATA

The study utilised primary cross-sectional data collected through a household survey conducted across four districts in West Bengal: Darjeeling, Kaliaganj, Namkhana, and Purba Medinipur. From each district, one administrative block was purposely selected to capture regional variation in educational outcomes. Around 150 student-level observations were collected from each district, resulting in a total sample size of 600 students. The survey instrument collected detailed information on household socio-economic characteristics, including parental education, income, and access to necessities. In addition, data related to access to private tuition, medium of instruction, and grade level were recorded.

To measure learning outcomes, students were administered a standardized mathematics assessment at the time of the survey. The test design followed the structure of the National Education Policy (NEP) 5 + 3 + 3 + 4 framework, grouping students into two learning stages[17]. Students in the preparatory stage (Grades III to V) were evaluated on two-digit number recognition and subtraction with borrowing, while students in the middle stage (Grades VI to VIII) were assessed on division of three-digit numbers by one-digit numbers involving carry-over operations. The total score was standardized to a maximum of 15 points and was used as a response variable in the empirical analysis.

3.1) METHODOLOGY

The first part of the statistical analysis presents the descriptive statistics of variables, including regional variation and the percentage of students receiving private tutoring. (Part 1).

The empirical strategy adopted a quantitative econometric approach to examine the determinants of student performance with a primary focus on the role of private tuition, along with a set of control variables capturing household, individual, and schooling characteristics. To account for unobserved heterogeneity, the models were estimated both with and without district-level fixed effects, allowing for comparison of coefficient stability(Part 2). Before estimation, multicollinearity was assessed using the variance inflation factor (VIF) to ensure that the explanatory variables were not highly correlated.

To strengthen the causal interpretation and address potential selection bias in access to private tuition, the study further employed an Augmented Inverse Probability Weighting (AIPW) estimator, which combines outcome modelling with propensity score weighting and provides a doubly robust estimate of the treatment effect of private tuition on students' mathematics performance (Part 3).

The interaction model was employed to examine whether the effect of private tuition differs across different socio-economic and educational groups. The interaction term between private

tuition and parental education was included in the regression framework to capture heterogeneous effects on students' mathematics performance (Part 4).

Part 1:

The descriptive statistics of the study variables provide an overview of the socio-economic and demographic characteristics of sampled students (Table 1). In addition, district-wide variation in private tuition participation has been examined to understand regional disparities in access to supplementary tutoring in the selected study area (Table 2).

Part 2:

2.1) The OLS model with fixed effects:

The econometric specification is

$$Y_i=\beta_0 + \beta_1 PT_i + \beta_2 PE_i + \beta_3 LI_i + \beta_4 age_i + \beta_5 gender_i + \beta_6 medium_i + \beta_7 class_i + \sum_{d=1}^{D-1} \delta_d DISTRICT_{di} + \in_i$$

Where,

Y_i = math score of studentsi (Remarks)
PT_i= access to private tuition
PE_i= parental education
LI_i= log family income
age_i = age of student
$gender_i$ = gender dummy
$medium_i$ = Bengali or English medium dummy
$class_i$ = class group dummy (class III to V & class VI to VIII)
$DISTRICT_{di}$ = district fixed effects
$\in_i$ = error term

2.2) OLS model without district fixed effect:

The econometric specification is

$$Y_i= \beta_0 + \beta_1 PT_i + \beta_2 PE_i + \beta_3 LI_i + \beta_4 age_i + \beta_5 gender_i + \beta_6 medium_i + \beta_7 class_i + \in_i$$

Where,

Y_i = math score of studentsi (Remarks)
PT_i= access to private tuition
PE_i= parental education
LI_i= log family income
age_i = age of student
$gender_i$ = gender dummy
$medium_i$ = Bengali or English medium dummy
$class_i$ = class group dummy (class III to V & class VI to VIII)

Before this estimation, multicollinearity among explanatory variables was examined using the Variance Inflation Factor (VIF). The result indicates that all VIF values were below the commonly accepted threshold of 5, confirming reliability in OLS regression[18].

Part 3:

AIPW (AugmentedInverse Probability Weighting) Estimation

The AIPW estimation was used to check the causal effect of private supplementary tutoring on students' academic performance after controlling for observed socioeconomic and demographic characteristics [19].

The AIPW estimator combines:

1. **Outcome regression model**
$E\langle Y_i|A_i, W_i\rangle$ = Q(Ai, Wi)

2. **Propensity Score Model**
$P\ (A_i\ =\ 1|W_i)$ = g (Wi)

3. **To estimate the Average Treatment Effect (ATE):**
ATE = E[Yi (1) – Yi(0)]

Where,
Yi = remarks
Ai = access to private tuition
Wi = vector of covariates, parental education, income, age, gender, medium, class group, and district

Part4:

Interaction Effect Model

To examine whether parental education moderates the effect of private tuition on academic performance, the interaction specification is:

$$Y_i=\beta_0\ +\ \beta_1\,PT_i\ +\ \beta_2 PE_i\ +\ \beta_3(PI_i \times PE_i) + \beta_4 LI_i\ +\ \beta_5\,age_i\ +\ \beta_6 gender_i\ + \beta_7 medium_i\ +\ \beta_8 class_i +\ \sum_{d=1}^{D-1}\delta_d\ DISTRICT_{di} + \in_i$$

Where,
$(PI_i \times PE_i)$ reprent interaction between private tuition and parental education.
Y_i = math score of studenti (Remarks)
PT_i = access to private tuition
PE_i= parental education
LI_i= log family income
age_i = age of student
$gender_i$ = gender dummy
$medium_i$ = Bengali or English medium dummy
$class_i$ = class group dummy (class III to V & class VI to VIII)
$DISTRICT_{di}$ = district fixed effects
$\in_i$ = error term

3.2) RESULT

The descriptive statistics presented in Table 1indicate that private tuition is highly prevalent among students, with nearly 71.33% of students receiving supplementary private tuition. Gender differences in access to private tuition are relatively small, although female students show slightly higher participation than male students. This result indicates that increasing parental investment narrows gender disparities in educational support.

With respect to the medium of instruction, students from Bengali medium schools reported a higher participation rate in private tuition than students from English medium schools. This indicates that the students in the Bengali medium school depend more on external academic support due to the difference in school resources.

The class group suggested that middle-level students from classes VI to VIII (72.11%) have a slightly higher participation rate in private tuition (72.11%) compared to preparatory-level students (70.77%). This pattern reflects the increasing academic pressure and examination-oriented preparation at higher levels of schooling. The continuous variables further provide insight into the socio-economic and academic background of the student. The average math test score is 9.63 out of 15, with moderate variation among students. The average parental education level is 15.41 years, suggesting that many households possess relatively substantial educational attainment.

Table 1: Descriptive Statistics of Distribution of Private Tuition across Student Groups

variable	category	Frequency	Tuition (%)	Mean	SD	Min	Max
Overall	-	600	71.33	-	-	-	-
Gender	Female (0)	283	72.08	-	-	-	-
	Male (1)	317	70.66	-	-	-	-
Medium of Instruction	Bengali medium (0)	283	71.63	-	-	-	-
	English Medium (1)	22	63.64	-	-	-	-
Class Group	Preparatory (class III–V)	349	70.77	-	-	-	-
	Middle (class VI - VIII)	251	72.11	-	-	-	-
Remarks	-	600	-	9.63	6.16	0.0	15
Parental Education	-	600	-	15.41	7.63	0.0	65
Log Income	-	600	-	9.32	0.64	7.6	11.29
Age	-	600	-	11.14	1.85	7.0	18

Source: Author's computation based on Primary survey data

The district-level analysis presented in Table 2 reveals substantial regional disparities in private tuition. The Namkhana reported the highest overall tuition participation 95.33% followed by Purba Medinipur (83.33%), whereas Darjeeling shows the lowest participation rate (36%). This variation indicates significant differences in educational attainment and socioeconomic conditions across districts. Gender based differences in participation are also

evident across the selected districts. In Kaliaganj, female students showed higher participation in private tuition compared to male students in other states.

Table 2: Descriptive Statistics Distribution of Private Tuition Across Districts and Gender (%)

Districts	Total	Male	Female	Male Tuition (%)	Female tuition (%)	Overall tuition (%)
Darjeeling	*150*	*69*	*81*	*34.78*	*37.04*	*36*
Kaliaganj	-	*77*	*73*	*62.34*	*79.45*	*70.67*
Namkhana	-	*92*	*58*	*94.57*	*96.55*	*95.33*
Purba Medinipur	-	*79*	*71*	*82.28*	*84.51*	*83.33*

Source: Author's computation based on Primary survey data

The result from OLS regression with district fixed effects in Table 3 indicates that access to private tuition is significantly and positively associated with students' math performance. Students receiving private tuition scored higher in the math test *(β = 1.58, p <0.01),* suggesting that supplementary tuition contributes positively to learning outcomes even after controlling for socio-economic and demographic characteristics. The reduction in the coefficient compared to the model without district controls indicates that part of the observed association is explained by regional heterogeneity across districts.

Parental education is positively and statistically significantly associated with academic performance ($\beta = 0.10$, $p < 0.001$), suggesting that students from more educated households tend to achieve better academic outcomes. In contrast, household income and age are not statistically significant, so income and age differences do not independently explain remarks. Female is the reference category for gender; the negative coefficient indicates that male students score slightly better than female students, but the relationship is statistically insignificant in the district fixed-effect model. Among institutional variables, English-medium schooling accounts for approximately 4.49 fewer marks than Bengali-medium schooling. For class group preparatory levels (class III to V) are the reference category, the students from the medium class (VI to VIII) score lower than the preparatory stage.

The district fixed-effect estimates indicate that students from Kaliaganj, Namkhana, and Purba Medinipur achieve significantly higher mathematics scores relative to students from Darjeeling.

Table 3: Effect of Private Tuition on Student Performance (OLS estimates)

Variables	*With District FE*	*Without District FE*
Access to Private Tuition (RC: No access to private tuition)	1.584*** (0.531)	4.631***(0.510)
Parent's Education	0.103***(0.029)	0.220***(0.034)
Log Income	0.268(0.334)	-0.058(0.369)
Age	-0.177(0.190)	-0.104(0.206)
Gender (RC: female)	-0.117(0.381)	-0.803*(0.436)
Medium (RC: Bengali)	-4.494***(1.217)	-0.555(1.212)
Class Group (RC: preparatory)	-1.416*(0.715)	-2.196**(0.751)
District (RC: Darjeeling)		-

Kaliaganj	1.654*(0.694)	
Namkhana	8.210***(0.689)	-
Purba Medinipur	6.095***(0.691)	-

Note: SE are reported in parentheses. The coefficient represents the estimated regression coefficient. Statistical significance levels are denoted by ***p<0.01, **p<0.05, *p<0.10.RC represents the reference category
Source: Author's computation based on Primary survey data

The AIPW (Augmented Inverse Probability Weighting) estimates in Table 4 indicate that students who receive private tuition perform better on student remarks than those who do not. The estimated mean outcome for the treatment group (students receiving private tuition) was *10.21 (SE = 0.315, 95% CI [9.597, 10.83])*, whereas the mean outcome for the control group was *9.17 (SE = 0.472, 95% CI [8.239, 10.09]).* The average treatment effect (ATE) was *1.05 (SE = 0.524, 95% CI [0.022, 2.07])*, suggesting that access private tuition increases student marks by approximately 1.05 points on average after adjusting for observed covariates through the AIPW approach. Since 95% CI does not include zero, the treatment effect is statistically significant at the 5% level. This finding implies that private tuition has a positive and meaningful impact on students' academic performance,as reflected in their remarks.

Table 4: Average Treatment Effect of Private Tuition on Student Remarks (AIPW Estimates)

variables	*β (Estimates)*	*SE*	*95% CI*	*N*
Mean of Exposure	*10.21*	*0.315*	*[9.597, 10.83]*	*428*
Mean of Control	*9.17*	*0.472*	*[8.239, 10.09]*	*172*
Mean Difference (ATE)	*1.05*	*0.524*	*[0.022, 2.07]*	*600*

Note: ATE – Average Treatment Effect. Estimates are obtained using the AIPW (Augmented Inverse Probability Weighting) method. The treatment effect is statistically significant as 95% confidence interval does not include zero.
Source: Author's computation based on Primary survey data

Table 5 represents the OLS interaction model, whether the effect of access to private tuition on students' remarks varies according to parental education, while controlling for socioeconomic and demographic characteristics with district fixed effects. The results show that access to private tuition and parental education individually has a positive and statistically significant association with students' remarks. The interaction term between private tuition and parental education is negative and marginally significant *(β = -0.096, SE = 0.052, p< 0.10).*This implies that the positive effect of private tuition decreases as parental education increases. Student from highly educated families already tend to perform better because parents may provide academic guidance and support at home. However, when students attend private tuition, they receive additional academic support outside the family environment. So private tuitions may partly substitute for the educational support usually provided by more educated parents.

Table 5: OLS Estimates with Interaction Between Private Tuition and Parental Education (District Fixed Effects Included)

variables	*β (Estimates)*	*SE*

Access to Private Tuition (RC: No access of private tuition)	*1.540***	*0.530*
Parental education (centred)	*0.164****	*0.045*
Private tuition × Parental Education	*-0.096**	*0.052*
Log income	*0.239*	*0.330*
age	*-0.164*	*0.191*
Gender (RC: female)	*0.083*	*0.381*
Medium (RC: Bengali)	*4.376****	*1.215*
Class group (RC : Preparatory)	*-1.479***	*0.717*
District (Darjeeling)		
Kaliaganj	*1.541***	*0.699*
Namkhana	*8.244****	*0.687*
Purba Medinipur	*5.907****	*0.703*

Note: SE is standard error. The coefficient represents the estimated regression coefficient. Statistical significance levels are denoted by ***p<0.01, **p<0.05, *p<0.10.RC represents the reference category. Parental education is centred around its mean.

Source: Author's computation based on Primary survey data

The empirical findings indicate that access to private tuition is positively associated with students' mathematics performance, although its marginal benefit declines with higher parental education. The result further demonstrates the influence of socio-economic and regional factors on educational outcomes. These findings provide important insights into educational inequality and supplementary tutoring practices, which are discussed in detail in the subsequent section.

4. DISCUSSION

The findings of this study demonstrate that private supplementary tutoring play a significant role in shaping student mathematics performance in West Bengal. The district-wide variation further highlights substantial regional disparities in access to private tuition. Namkhana and Purba Medinipur reported considerably higher participation rates compared with Darjeeling. These differences may be associated with variation in educational infrastructure, accessibility, household awareness, and socio-economic conditions across regions. This finding suggests that regional context plays an important role in determining educational opportunities and learning support.

The OLS regression indicates that access to private tuition has a positive and statistically significant association with student mathematics performance. Students who take private tuition score significantly higher than those who do not havea tutor. The reduction in the tuition coefficient after including district fixed effects suggests that part of the observed relationship is influenced by regional heterogeneity, implying that the educational context and location-specific factors also contribute to learning outcomes. Parental education also emerged as another significant determinant of academic performance. Students from more educated households perform better in mathematics, which supports the argument that educated parents are more capable of providing academic guidance, education, anda supportive learning environment at home [20]. However, household income was statistically insignificant in the regression models, suggesting that educational support and parental

awareness may matter more than income alone in influencing learning outcomes within the sampled population.

The important finding of the study is the interaction effect between private tuition and parental education, which shows that students from less educated households appear to benefit more from supplementary tutoring. This may occur private tuition partly compensates for the lack of academic support available at home. This finding supports the compensatory role of private tuition in addressing educational disadvantages among students from weaker educational backgrounds.

The AIPW further strengthens the empirical finding by demonstrating that private tuition has a statistically significant positive treatment effect on student mathematics performance. Since the AIPW estimator combines outcome regression and propensity score weighting, the results provide more robust evidence after adjusting for observable selection bias. The estimated average treatment effect indicates that private tuition increases the score of students by one mark on average. This suggests that the supplementary tutoring contributes meaningfully to learning outcomes beyond the simple correlation observed in a conventional regression model.

The significant district effects indicate that educational inequality in West Bengal is not only socio-economic but also spatial in nature. The study has certain limitations; this analysis is based on cross-sectional primary survey data, which limits the ability to establish long-term causal relationships between private tuition and academic performance. Future research may include all districts with a larger sample size for broader generalization. The study does not cover the difference in quality, duration, and intensity of private tuition. More focused research can be on geographical vulnerability regions, such as hilly and coastal areas, which may provide deeper insights into regional educational inequalities.

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